of the projector, might be enlarged to *any extent.* The span of the bridge is evidently not agreed upon, nor is the construction of the piers determined; we are assured that we may have any span we like, and that there is no difficulty about the piers; in fact, the only thing wanted to complete this great national work in *three* years, appears to be a subscription of eight millions sterling to the credit account of the Channel Bridge Company.

The vagueness of the scheme is the safeguard of its promoters. We cannot even describe the propositions without running the risk of being contradicted on every point; it is even intimated that it is premature to discuss the scientific questions of the Channel Bridge scheme.

We have a few facts, however, on which we may safely enlarge. It is admitted, that from Dover to Blanc Nez, a distance of twenty-one miles, a number of piers are indispensable. In 1868, the distance was to be crossed by ten spans, each over 9,000 feet in the clear, and we have a diagram of that monster bridge. In 1869 rumour will have it that the number of spans is to be increased from ten to thirty, making the reduced span still over 3,000 feet in the clear. With the first proposition we should have had nine piers, with the latter, twenty-nine, washed by the waters of the Channel.

Whatever the ultimate number of piers may be, it is evident that some of them must be constructed in water exceeding 30 fathoms, or 180 feet in depth (according to the Admiralty Chart); moreover, these piers are to be 360 feet above high water, making the total height of the structure of some of them over 540 feet from the bottom of the Channel. Let us see how one of these pyramids is to be constructed midway the Channel.

The projector discards masonry, for no operations 180 feet below water level are practicable; and as the foundations themselves would have to be carried down another indefinite number of feet, the depth and consequent pressure would render life, and therefore work, impossible.

A new construction of piers had to be invented, and herein should be found the virtue of the design; let the agents of the Channel Bridge Company tell their story:—

> The project depends in effect on two remarkable innovations in the construction and establishment of the piers and metallic beams. In addition to the considerable height to which the former rise above the water (120 yards), the bases of the piers are sunk to the bottom at a depth varying from 28 to 52 yards. Except the centre one, all the piers at their foundations measure 130 yards in width and 87 yards in length, diminishing upwards, and forming at the summit a square of 66 yards on each side. The centre pier will be half as large again as the others. All the pieces composing the work are of cast-iron, and furnish, without increasing the weight, a power of resistance superior to all other kinds of construction.
>
> As such ponderous piers could not be erected by the ordinary means, M. Boutet proposes to construct on the shore their lower parts or bases to a height sufficient to rise ten yards above high water, and as soon as the iron skeleton is put together and bolted, a number of large sheet-iron buoys are distributed about the immense surface of the base. At low water the metallic framework thus prepared is made to slide upon the shore to low-water mark. The tide, in rising, raises this raft or base of iron lightened by the buoys, and floats it. A tug steamer then removes it to its place, previously indicated by one of a line of buoys attached to an iron cable, stretched across the Straits at a depth of eighteen yards. By raising one of the buoys attached to the raft it is made to descend very slowly, the top being just above the level of the sea when the base touches the bottom. Thus are avoided all the preliminary works under water, which constitute the greatest difficulty in the way of a bridge across the Channel.

Certainly, we have here Baron Munchausen over again. These cast-iron piers, with a base of 390 ft. by 260 ft., over 200 ft. high, we are informed, are to weigh about 2,500 tons. What is the thickness of their metal to be? Information is wanting on this point; but an iron structure of these dimensions, to bed itself on the bottom of the Channel, could not be designed of less than ten times the weight named.

Assuming, for the sake of argument, that the rise of the tide would float that structure away by the means above described—and our business is to analyse the project as it is, not to suggest or attempt to improve on it—may we not ask with surprise, where would the centre of gravity of this floating structure be? Its centre of gravity would be about ninety feet above the level of the water, and at least one hundred feet *above* the centre of displacement. Why do our ships not upset, what insures their stability, and why do they right themselves? Mainly, because their centre of gravity is in its lowest position, *below* their centre of displacement. Here, however, we have a floating structure in which the centre of gravity would be enormously *above* the centre of displacement, and in its highest position. A slight oscillation, a breath of wind would overturn it, and suppose it could be floated away from shore, it would topple over—right itself upside down; the "sheet-iron buoys" would be uppermost, and the structure below them, forming a gigantic wreck somewhere in the Channel.

So much, then, about the piers. It may give the ordinary reader an idea of the character of this scheme. Shall we say anything about the 9,000 and odd feet clear span? At first sight it appears to be a typographical error; surely 900 and odd feet were meant; but then we meet with the fact of the Channel being divided into *ten* spans, so there is no getting out of it.

The whole proposition is the offspring of a highly imaginative mind. Of all the schemes or suggestions to cross the Channel by rail, this is the most incoherent. *There is nothing in it*—not one point of merit. It is not bold, because it lacks the spirit of boldness, viz. Sense. Not a trace of an engineer's mind is to be found in it. Our asylums produce innumerable schemes of this kind, but they are not permitted to disturb the public mind. It is a relief to have done with it. We are glad to say there are several projects which do not lack either sense or ability on the part of the originators. Some of them appear practicable, and one or two highly promising of success, and these will form the subject of our next communication.

DANA'S MINERALOGY

A System of Mineralogy: Descriptive Mineralogy comprising the most Recent Discoveries. By James Dwight Dana, Silliman Professor of Geology and Mineralogy in Yale College, etc., aided by George Jarvis Brush, Professor of Mineralogy and Metallurgy in the Sheffield Scientific School of Yale College. Fifth edition, 8vo. pp. 827, figures 617. (London: Trübner & Co.)

I.

FORTY years ago mineralogy was a fashionable subject in England; wealthy people collected minerals, though probably but few of those who did so ever made mineralogy a serious study. But mineralogy, under the then received doctrines of Mohs, was rather a system than a science; rather a system by which the place of a mineral in a classified list, grouped after little else than external appearances, could be determined by a few simple experiments, than a science dealing with the more subtle properties and qualities of the objects it classifies, and treating external resemblances as of no importance unless associated with analogies in composition or chemical type. No doubt it is to a great progress of mineralogy in this latter direction, associated as it has been with a corresponding development of crystallography and crystallographic optics, that the falling off in the votaries of these sciences is in a great measure due.

The mere collector for collecting's sake would prefer now-a-days to expend his money on shells or his research on fossils or plants, for a tolerable familiarity with which little preliminary education is needed, to investing his means and puzzling his mind with a science which has become a department of chemistry, and needs, besides sound chemical ideas, a thorough practical acquaintance with another and that a mathematical science, namely, crystallography.

To a similar cause is due, in part at least, the comparative indifference with which crystallography is treated by chemists and mineralogy by our geologists.

No doubt these two great sciences, chemistry and geology, between them cover nearly all the ground occupied by mineralogy. But our chemists are engrossed by great problems that may be said to be involved in the nature, if not even in the structure, of the gaseous molecule; they have hardly yet turned to that side of the problem which will one day be illustrated by the physics of the crystal molecule. So again the geologist in his character of historian of the earth is occupied with the relations of the manifold forms of life that have congregated on our globe, and their distribution in time; or else with the great dynamical causes that have engineered this "dædal earth" of ours into its present superficial form. And in England the chemical causes to which so large an amount of change in the character and bulk of rocks and in minerals is due are rarely within the grasp of our leading geologists.

In Germany it is otherwise. There, a preliminary education in mathematics or in chemistry, and by natural sequence in crystallography and mineralogy, is the almost universal introduction to the study of geology. So that to the German student, crystallography, as a science of observation with the goniometer, and of calculation with formulæ, is no rare accomplishment; and the little collection he makes during his student years, whether of minerals or of chemical preparations and crystals, forms a nucleus round which is gathered a great deal of valuable and exact knowledge, which he builds on work with his goniometer and his balance, and often with the microscope at home or his hammer in the field. The School of Mines here is producing a few men with many of these qualifications, but it may be questioned whether a more mathematical basis is not needed in that as in other similar educational institutions in England.

At any rate we do not turn out here the many-sided geologists that Germany produces, as witness the school of chemical geologists with Bischof at its head, or the admirable works on petrology by German authors; for the German geologist does not write on rocks till he has acquired a scientific acquaintance with the minerals that compose them.

In France, again, the nation of Haüy, if mineralogy, perhaps from the smaller importance of French mining industry, is not so widely pursued as it is in Germany, it has nevertheless always had its careful, thorough, and scientific votaries. Indeed, in our own day, the researches of Des Cloizeaux, following up those of Grailich, and his brilliant little constellation of Viennese crystallographers, have shown how absolutely essential is the study of the optical constants of crystals to any complete science of chemistry or mineralogy. We may, indeed, console ourselves for our shortcomings in England by the reflection that to an Englishman is due a system of crystallographic notation, and an extended use in crystallography of spherical trigonometry, which have long given to that science a greater symmetry and simplicity in its formulæ; so that now the system of Professor W. H. Miller is gradually displacing every other on the Continent.

But when we turn from Europe to America, we should expect that we should have to judge by other standards; for there a sterner call summons men to the study of mineralogy than is the case in the Old World. Where any pioneer on a new bit of mountain land may light upon mineral wealth like that of the Washoo district of the territory of Idaho, there is a need for pioneers who are mineralogists; and it is but justice to the American instinct for perceiving, and genius for supplying, whatever is wanted under novel conditions of life, to say, that in mineralogical science and mining enterprise the Americans have been equal to the demands and to the splendid opportunities that the New World has presented to them.

Of this the work, the title-page of which heads this article, is an admirable evidence. Written to meet the wants of eager and intelligent young ore-seekers in the vast stretches of plain and mountain between the Atlantic and the Pacific, it has satisfied these wants perfectly, and helped to produce (we had almost written has produced) an admirable American school of mineralogists. But it has done more than this: it may almost be called the text-book of mineralogy for Europe; and it is so for the reason that its ingenious and talented author is laborious; and is not only laborious, but able to throw off a prejudice like an old garment. It is this freshness of mind and power of work that has made the successive editions of his mineralogy not only *not* reprints, but essentially original books, and even made them an interesting pyschological study of one who may be taken as a typical American man of science.

The chief features that distinguish the large and handsome volume representing Professor Dana's new, that is to say, his fifth edition, are—Firstly, modifications in his system of classification; Secondly, alterations in the nomenclature; and Thirdly, a new chemical notation. Professor Dana still retains his peculiar graphic method for the representation of the zones of crystals and his notation for their planes. Both of these, we believe, he will discard in some future edition which we earnestly hope that he may live to carry through. The notation is rather complicated than simplified by the employment as symbols of the letter *i* in its different phases of italic and capital, which, together with the figure 1, are used to represent what, in fact, are the most frequently recurrent and concurrent planes of a crystal. The far greater elegance of the stereographic projection for the representation of the zones of a crystal than the sort of contracted and symbolised Quenstedtian method employed by Professor Dana will certainly prevent this latter from ever becoming adopted in other works. Passing from the crystallographic to the chemical notation, we may say that Professor Dana accepts a sort of nuclear theory of chemical combination, and illustrates this by a corresponding notation. As, however, the use of this system is only partially introduced into the work, we may dismiss it with the remark that, inasmuch as the use of formulæ of one shape or another to express a particular compound can only be a relative and not an absolute expression of the modes in which its elementary units are combined, when one such formula or system of formulating is to be conventionally selected for adoption, that will be the best to select which expresses best the relations between the compounds from the point of view of the author employing them. Professor Dana's does not seem to us to meet this requirement as from the point of view of the mineralogist.

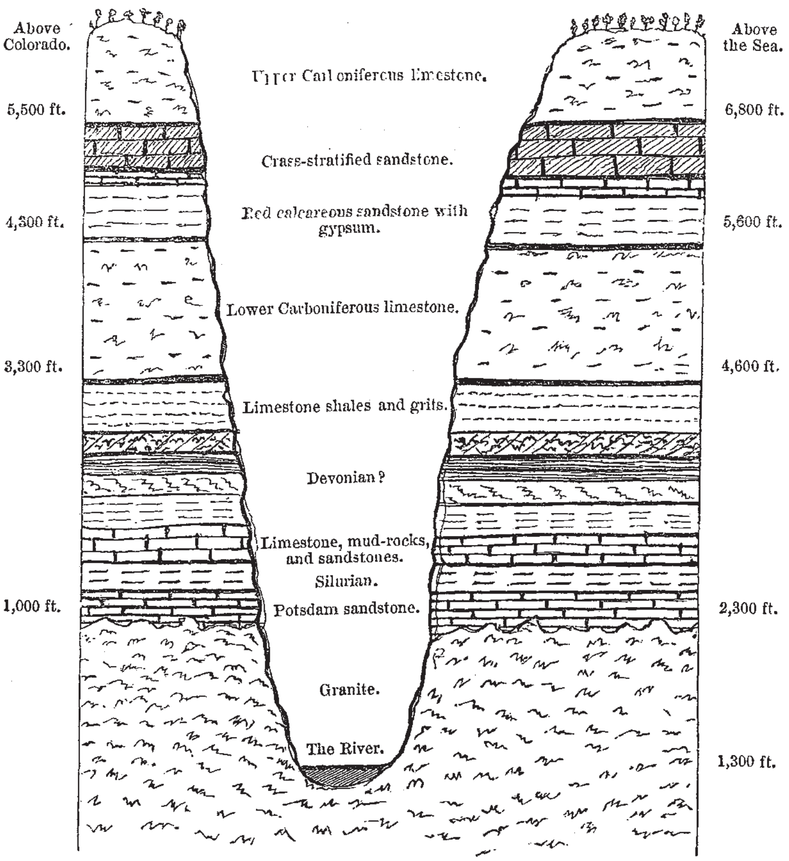
N. STORY MASKELYNE.

BELL'S NEW TRACKS IN NORTH AMERICA

New Tracks in North America: A Journal of Travel and Adventure in 1867–68. By W. A. Bell, M.B., F.R.G.S., &c. With a map, 20 lithographs, 22 woodcuts, and 3 botanical plates. 2 vols., 236 and 322 pp. (Chapman & Hall.)

THIS is an unusually important book of travels, giving interesting particulars of the vast wild Western country which, though still the home of the Apache and the Buffalo, is every day being more and more brought into subjection by the settlers, traders, miners, capitalists, and railways of the "Anglo-Saxons" of America, as Dr. Bell calls them.

The author was well placed for obtaining reliable information, having been attached in 1867 to the surveying expeditions of the Pacific Railway as photographer and physician. In this manner he travelled "about 5,000 miles beyond the pale of civilisation and railways." His contributions to the physical geography of the astonishing country south-west of the Rocky range are carefully done. He writes a brief treatise on the natural drainage system of the district, and especially of the Great Basin, which is considerably larger than France, and so-called because none of its rivers reach the sea. The reason of this is not that it is a basin with a rim all round to act as an insurmountable barrier to drainage, but rather because it is in reality a collection of hundreds of smaller basins, each of which has its stream and lake, which lose by evaporation and percolation what is supplied by the limited rainfall. Cultivation is, however, increasing the rainfall in Utah, and the Great Salt Lake has consequently of late years been steadily rising. The rainfall from year to year is irregular. At Fort Yuma, on the borders of California and Arizona, it was in four recent years 0·33, 8·57, 4·20, and 2·94 inches. Irrigation must be resorted to for all agricultural operations.


Above Colorado.
Above the Sea.
Upper Carboniferous limestone.
5,500 ft.
6,800 ft.
Cross-stratified sandstone.
Red calcareous sandstone with gypsum.
4,300 ft.
5,600 ft.
Lower Carboniferous limestone.
3,300 ft.
4,600 ft.
Limestone shales and grits.
Devonian?
Limestone, mud-rocks, and sandstones.
Silurian.
1,000 ft.
Potsdam sandstone.
2,300 ft.
Granite.
The River.
1,300 ft.

SECTION OF THE CANON OF THE COLORADO ON THE HIGH MESA, WEST OF THE LITTLE COLORADO (BY J. S. NEWBERRY, M.D.)

The barren, monotonous mountain ranges of the great basin are rich in minerals. One silver lode, the Comstock, yields annually four millions sterling, or more than all the mines in Mexico, and Nevada furnished twenty million dollars of gold in 1867 to California's twenty-five. Copper and iron are also plentiful, and the unworked coal-fields are numerous. Hydraulic power is now employed in mining in California. The machine used was invented in 1852 by one Mattison, of Connecticut, and directs a stream of water from a two-inch pipe under a pressure of perhaps 200 ft. perpendicular, which gives a tremendous force, against a bank or hill-side, containing *placer* gold, tearing down the earth into the washing sluices